In the Specification

Amend the title as follows:

COMMON SECOND LEVEL FRAME EXPOSURE METHODS FOR MAKING EMBEDDED ATTENUATED PHASE SHIFT MASKS

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[0005] Other PSMs for example, embedded attenuated phase shift masks (EAPSMs), utilize opaque layers of chromium to mask non-critical areas outside of the critical structure areas. As used herein, the term critical structures includes lines, contacts and other active regions to be exposed in a resist layer, subsequently developed, etched and/or deposited on the wafer to form an integrated circuit device or portion thereof. These phase shifting image segments typically impart a 180° phase shift of the polarization of the energy beam, e.g., visible or ultraviolet light. In manufacturing an EAPSM, a first exposure is typically made to create the phase shifting and opaque image segments on the substrate corresponding to areas of the critical structures, and a second exposure is made to selectively remove the opaque material in the area of critical structures but to leave the opaque [[and]] the area surrounding the area of critical structures.

[0018] Fig. 2 is a cross-sectional elevational view of the completed first level exposure, developing and etching of the EAPSM of Fig. 1.

[0024] Fig. 1 depicts the commencement of the process of fabricating the EAPSM in accordance with the present invention, wherein a mask substrate has a base 20 which is transparent to the energy source to be used in the lithographic production of the integrated circuit device, and which is overlaid with a layer 22 of a phase shifting material ~~which is~~ and then overlaid with a material layer 24 which is opaque to the lithographic energy source. Typically, the transparent substrate base 20 is quartz. The phase shifting material may be any conventionally used in the art such as $MoSi_x$, $MoSi_xO_yN_z$, Si_xN_y or CrO_xF_y. In addition to these phase shifting materials, the quartz substrate itself may be made to induce a phase shift by etching the image segments to different levels, i.e., thicknesses, beneath the surface of substrate base 20 such that desired phase shift is imparted to the energy beam.

[0025] Opaque layer 24 may be made of any suitable material such as chromium. Deposited over the phase shifting and opaque layers is a ~~resist layers is a~~ resist layer 26. This resist may be a positive resist, in which a region to be printed is exposed to the energy source, or a negative resist in which the region to be printed is not exposed to the energy source. In the resist layer 26 depicted in Fig. 1, regions 26a, 26b, 26c and 26d are to be developed and removed from resist layer 26 in order to etch the underlying opaque layer 24 and phase shifting material layer 22. These image containing areas 26a, 26b, 26c and 26d are created by a modulated electron beam or laser writing tool 18 which directly writes the image into the resist layer without the use of a mask.

[0026] Following the first level exposure of resist layer 26, the resist layer is developed and areas of 26a-26d are removed. Thereafter, a suitable etchant is utilized to etch corresponding openings in opaque layer 24 and phase shifting material layer 22. After removal of the remaining resist layer 26, the resulting structure is depicted in Fig. 2, wherein phase shifting segments 22a, 22b, and 22c have overlying opaque segments 24a, 24b, 24c, respectively. These ~~image forming~~ phase shifting segments ~~232a-22c~~ 22a, 22b and 22c are used for forming images in the areas of critical structures to be exposed using the EAPSM. This critical structure area is shown having a width dimension C. Portions of the opaque layer 24 also remain outside of this critical area.

[0028] In fabricating the EAPSM mask in accordance with the present invention, a second resist layer 28 is applied over the etched opaque and phase shifting image segments created by the first exposure on EAPSM substrate base 20, and mask 30 is secured thereover (Fig. 4). Energy source 34, utilizing visible light, UV or other energy beams 36, simultaneously exposes resist layer portion 28a corresponding to the critical area of the mask. After exposure, the second resist layer 28 is developed and exposed area 28 removed, to arrive at the structure shown in Fig. 5. While resist layer portions 28b and 28c remain over the areas outside of the critical structure area, and all resist is removed from within these portions. The remaining opaque layer regions 24a, 24b and 25c within the critical area are then etched away, and the remaining second level resist is removed, which results in the structure shown in Fig. 6. In the finished EAPSM mask depicted, the unwanted opaque layer 24 segments have been removed from within the critical area C, leaving only the chromium layer segments 24d, 24e in

the non-critical areas outside of the critical area. The remaining phase shifting image segments 22a, 22b and 22c may now be used in connection with transparent substrate base 20 to impart the desired phase shifting pattern, using a photolithographic process, in the active area of integrated circuit device wafer substrate.